

REMARKS

The independent claims (claims 1, 17, and 45) have been amended to specify (1) that the electrolyte includes the bis(oxalato)borate salt at a concentration of from 0.005 M to 0.1 M; (2) for claims 1 and 45, that the cathode includes an aluminum current collector (claim 17 already includes this limitation); (3) that the cell includes a positive lead including aluminum, titanium, or steel; (4) for claims 1 and 45, that the cell is a primary cell (claim 17 already includes this limitation); (5) for claim 17, that the anode includes lithium (claims 1 and 45 already includes this limitation); and (6) that the bis(oxalato)borate salt is either a metal or an ammonium salt. Support for the salt concentration can be found on page 5, lines 3-12. Support for the positive lead limitation can be found on page 8, lines 9-10. Support for the metal or ammonium bis(oxalato)borate salt limitation can be found on page 4, line 27 - page 5, line 1, which lists metal and ammonium salts as examples.

Claims 12 and 24 have been amended to specify a concentration range of from 0.005 M to 0.05 M. Support for this range also can be found on page 5, lines 3-12.

New claim 59 depends from claim 17 and specifies that the cathode contains iron disulfide (FeS_2). Support for this claim can be found on page 7, line 15.

No new matter has been added.

Applicants believe the amendment to require a low limit for the salt concentration addresses both the 35 U.S.C. § 112, ¶ 2 rejection and the 35 U.S.C. § 102(b) rejection based on Miyaki et al., U.S. 2002/0114993 ("Miyaki"). Applicants request that the rejections be withdrawn.

Claims 1-5, 12, 14-19, 24, 28, 45, 46, and 59 are pending.

The invention generally addresses a problem that can occur in primary lithium batteries. Cathode active materials, for example, MnO_2 and FeS_2 , can include structural water that cannot be removed fully with even vigorous drying. That structural water can cause the corrosion of the cathode current collector, which is made of a metal such as aluminum. The corrosion can occur, for example, at the couple between an aluminum current collector and a steel positive lead. See the discussion on page 1, line 22 - page 2, line 2 of the specification.

Applicants discovered that this type of corrosion in primary lithium batteries can be suppressed by including a bis(oxalato)borate salt in the electrolyte. Surprisingly, applicants

discovered that even small quantities (less than 0.1 M) of the bis(oxalato)borate salt can suppress corrosion. See the results presented on pages 9-12 of the specification.

The independent claims as amended require that the bis(oxalato)borate salt is present in the electrolyte at a concentration of between 0.005 M and 0.1 M.

Applicants note that although lithium bis(oxalato)borate (LiBOB) is a preferred bis(oxalato)borate salt, bis(oxalato)borate salts including other cations can be used; see, for example, the other salts named beginning on page 4, line 28.

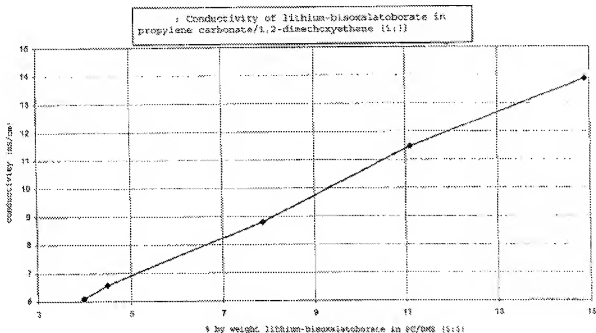
Claims 1-5, 12, 17-19, 24, 28, 45, and 46 have been rejected under 35 U.S.C. § 103(a) over Miyaki in view of Wietelmann et al., U.S. Pat. 6,506,516 ("Wietelmann") and Furbringer, U.S. Pat. 5,886,196 ("Furbringer"). Applicants request that the rejection be reconsidered and withdrawn.

Miyaki describes secondary (rechargeable) lithium batteries that have good rechargeability (a characteristic of secondary batteries) because of a "protective layer" on one or both electrodes. The batteries include an electrolyte containing a lithium salt. The lithium salt is present to provide the electrolyte with conductivity. As the Examiner recognizes, Miyaki does not disclose using LiBOB or any other bis(oxalato)borate salt for any purpose, let alone for providing corrosion resistance in particular at the couple between an aluminum cathode current collector and the positive lead.

Wietelmann discloses using LiBOB as the conductive salt in the electrolyte of lithium ion batteries. Wietelmann primarily is focused on procedures for synthesizing LiBOB, but also provides guidance regarding the quantity of LiBOB that should be included in the electrolyte to provide adequate conductivity. The relevant discussion from Wietelmann, and the Figure referenced in the discussion, are provided below for the convenience of the Examiner

Furthermore, the conductivities which can be achieved with the salt in accordance with the invention are note worthy. Thus, a 0.56 m solution in a 1:1 mixture of EC and DME has a conductivity of 10.3 mS/cm at room temperature. In the usual solvent mixture propylene carbonate (PC)/DME (1:1), the conductivity of lithiumbisoxalatoborate in the case of different concentrations was measured (FIG. 1). It can be inferred from the measurement results that with concentrations of up to 15% by weight, conductivities of up to 14 mS/cm are achieved (see FIG. 1). These values are at the same level as, or even above, the conductivities which can be achieved with LiPF₆. Thus, for 1 m solutions of LiPF₆ in dimethyl carbonate (DMC)/EC, 11.0 mS/cm is achieved.

The molar mass of 193.8 g/mol is admittedly approximately 27% above that of the LiPF_6 , but clearly below that of the borates described in DE 19633027 A1. This is not problematic, however, because electrolytes with lithium-bis(oxalatoborate) are also sufficiently conductive at lower concentrations (for example approximately 0.5 mol/l).



Thus, Wietelmann touts that LiBOB can be used to achieve adequate conductivity at “lower” concentrations of 0.5 M. Furthermore, with regard to Fig. 1, applicants note that 0.1 M LiBOB corresponds to about 1.94% LiBOB in PC/DME (1:1). That quantity provides such low conductivity that it is not even included in Fig. 1.

In summary, Wietelmann discloses using LiBOB as a potential replacement for LiPF_6 because it has good conductivity. But Wietelmann teaches that concentrations of LiBOB much higher than 0.1 M should be used to provide good conductivity to the electrolyte. And Wietelmann does not suggest that low concentrations of LiBOB, or any other bis(oxalato)borate salt, can suppress the corrosion at the aluminum cathode current collector/positive lead couple in a primary lithium battery.

Furbringer relates to using hydrogen bis(oxalato)borate as “a protonic acid catalyst in condensation reaction.” Furbringer does not relate to batteries, or provide guidance that would

lead a person of ordinary skill in the art to believe, for example, that Wietelmann's LiBOB would provide adequate conductivity to an electrolyte used in a primary lithium battery at concentrations of 0.01 M or less. Nor does Furbringer teach that bis(oxalato)borate can be used at low concentrations in the electrolyte of a primary lithium battery to suppress corrosion at an aluminum cathode current collector/positive lead couple.

Finally, applicants note that the claims require either a metal or ammonium bis(oxalato)borate salt, whereas Furbringer is using a hydrogen bis(oxalato)borate as the catalyst.

Thus, applicants request that the 35 U.S.C. § 103(a) rejection based on Miyaki, Wietelmann, and Furbringer be reconsidered and withdrawn.

Claims 1-5, 12, 17-19, 24, 28, 45, and 46 have been rejected under 35 U.S.C. § 103(a) over Miyaki in view of DE 10049097 ("DE '097") and Furbringer. Applicants also respectfully request that this rejection be withdrawn. A certified full translation of DE '097 is enclosed. DE '097 discloses lithium batteries including electrolytes containing lithium salts such as LiBOB to provide conductivity. DE '097 focuses on the problems that can occur when the solvents used in the electrolyte contain protic contaminants such as water and hydrogen fluoride. DE '097 addresses that problem by using a binary hydride, such as LiH, to dry the solvents.

The only guidance DE '097 provides regarding the quantity of "conducting salt", in particular LiBOB, that should be used in the electrolyte is in Table 1 (page 3), where DE '097 discloses an electrolyte that contains 10.5% by weight "LOB" (presumably LiBOB). This quantity is way, way more than 0.1 M.¹ DE '097 does not suggest that small (0.1 M or less) quantities of LiBOB would provide adequate conductivity. Nor does DE '097 teach that small quantities of LiBOB can suppress corrosion of an aluminum cathode current collector/positive lead couple.

Thus, applicants request that the 35 U.S.C. § 103(a) rejection based on Miyaki, DE '097, and Furbringer be withdrawn.

Dependent claims 14-16 have been rejected under 35 U.S.C. § 103(a) over the combination of references discussed above, and further in view of Krause et al., U.S. Pat.

¹Table 2 in DE '097 lists LOB-containing solvents but does not provide the specific LiBOB concentration. Consistent with DE '097's focus on drying the solvents, only the quantities of water and LiH are listed.

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5,691,081 ("Krause"). Krause adds nothing of significance to the rejections (of independent claims 1, 17, and 45) discussed previously, and the rejections based on Krause should be withdrawn for the same reason.

Applicants submit that the claims are in condition for allowance and such action is respectfully requested.

Please apply any other charges or credits to deposit account 06-1050.

Respectfully submitted,

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